Amendments to the Claims

The claims have been amended as follows. Underlines indicate insertions and ~~strikeouts~~ indicate deletions.

Claim 1 (currently amended): A thermal management system for a vehicle, comprising:

a heat exchanger having a thermal energy storage material provided therein;

a first coolant loop thermally coupled to an electro-chemical storage device located within the first coolant loop and to the heat exchanger;

a second coolant loop thermally coupled to the heat exchanger, the first and second loops configured to carry distinct thermal energy transfer media; ~~and~~

an interface configured to facilitate transfer of heat generated by an internal combustion engine to the heat exchanger via the second coolant loop in order to selectively deliver the heat to the electro-chemical storage device; and

a second heat exchanger provided in the first coolant loop.

Claim 2 (currently amended): The system of claim 1, wherein the heat generated by the internal combustion engine is provided to the first mentioned heat exchanger to regenerate the thermal energy storage material, and the electro-chemical storage device comprises one or more batteries, capacitors, fuel cells, or combinations thereof.

Claim 3 (original): The system of claim 2, wherein regenerating the thermal energy storage

material includes converting the thermal energy storage material from a solid state to a liquid state.

Claim 4 (original): The system of claim 1, wherein the first coolant loop comprises a coolant mixture that is different from the thermal energy transfer medium flowing through the second loop.

Claim 5 (original): The system of claim 4, wherein the thermal energy transfer medium flowing through the second loop comprises a coolant used in association with the internal combustion engine.

Claim 6 (original): The system of claim 5, wherein the interface comprises one or more fluid supply paths in fluid communication with the second coolant loop.

Claim 7 (currently amended): The system of claim 6, wherein the heat generated by the internal combustion engine is provided to the heat exchanger via at least one of the fluid supply paths and the second coolant loop, the fluid supply paths being thermally coupled to a radiator core of the vehicle, and upon providing the heat to the first mentioned heat exchanger, at least one of a sensible heat or a latent heat of fusion of the thermal energy storage material is increased from a thermal state to a higher different thermal state.

Claim 8 (currently amended): The system of claim 6, wherein the heat generated by the internal combustion engine is provided to the heat exchanger via at least one of the fluid supply paths and the second coolant loop, the fluid supply paths being adapted to be thermally coupled to a

radiator core of the vehicle, and upon providing the heat to the first mentioned heat exchanger, a sensible heat as well as a latent heat of fusion of the thermal energy storage material are increased from a thermal state to a higher different thermal state.

Claim 9 (original): The system of claim 1, wherein the heat generated by the internal combustion engine is selectively delivered to heat a passenger cabin of the vehicle via the second coolant loop, or delivered to the electro-chemical storage device via the first coolant loop to increase a temperature of the electro-chemical storage device.

Claim 10 (original): The system of claim 1, wherein the thermal energy storage material comprises a phase change material configured to change from a solid state to a liquid state and vice-versa during select conditions.

Claim 11 (currently amended): A thermal management system for a vehicle, ~~The system of claim 1, further~~ comprising:

a heat exchanger having a thermal energy storage material provided therein;

a first coolant loop thermally coupled to an electro-chemical storage device located within the first coolant loop and to the heat exchanger;

a second coolant loop thermally coupled to the heat exchanger, the first and second loops configured to carry distinct thermal energy transfer media;

an interface configured to facilitate transfer of heat generated by an internal combustion engine to the heat exchanger via the second coolant loop in order to selectively deliver the heat to the

electro-chemical storage device;

a second heat exchanger provided in the first coolant loop, wherein, in operation, ~~the~~ thermal energy transfer medium flowing in the first coolant loop is selectively flowed through the second heat exchanger to reduce a temperature T_{Batt} to within a predetermined temperature range;

a bypass fluid path configured to deliver the thermal energy transfer medium circulating in the first coolant loop, bypassing the heat exchanger, to the electro-chemical storage device; and

first and second pumps to enable circulation of the thermal energy transfer media provided in the respective first and second coolant loops.

Claim 12 (original): The system of claim 11, further comprising a plurality of three-way valves configured to selectively permit the thermal energy transfer medium flowing in the first coolant loop to flow through the heat exchanger or the bypass fluid path.

Claim 13 (original): The system of claim 11, wherein the thermal energy transfer medium flowing in the first coolant loop is flowed via the bypass fluid path if a temperature T_{Batt} of the electro-chemical storage device is above a predetermined maximum threshold temperature T_{max}.

Claim 14 (original): The system of claim 11, wherein the thermal energy transfer medium flowing in the first coolant loop is enabled to flow through the heat exchanger if a temperature T_{Batt} of the electro-chemical storage device is below a predetermined minimum threshold temperature T_{min}.

Claim 15 (original): The system of claim 11, wherein the second heat exchanger comprises air-to-glycol mixture heat exchanger.

Claim 16 (currently amended): The system of claim 11 ~~1~~, wherein the first mentioned heat exchanger comprises a liquid-to-liquid heat exchanger.

Claim 17 (currently amended): The system of claim 11 ~~16~~, wherein the first mentioned heat exchanger comprises:

heat exchange tubing configured to exchange heat between the thermal energy storage material and the respective thermal energy transfer media circulating in the first and second coolant loops; and

heat exchange fins configured to enhance the heat exchange, wherein the thermal energy storage material is encapsulated in one or more sections of flexible tubing comprised in the heat exchanger, wherein encapsulation in the one or more sections of the flexible tubing reduces a ratio of encapsulant volume relative to volume of the thermal energy storage material.

Claim 18 (currently amended): The system of claim 11 ~~16~~, wherein the first mentioned heat exchanger is configured to control heat supplied to components of the vehicle during select phases of vehicular operation including cold-start conditions, normal operating conditions, and hot-operating conditions.

Claim 19 (original): The system of claim 1, wherein the heat generated by the internal

combustion engine is stored in the thermal energy storage material for use during cold-start conditions of the vehicle to increase a temperature T_{Batt} of the electro-chemical storage device.

Claim 20 (currently amended): The system of claim 1, wherein the first mentioned heat exchanger is configured to preheat the electro-chemical storage device and a passenger cabin of the vehicle to enhance performance of the electro-chemical storage device and enhance cabin comfort of the passenger cabin.

Claim 21 (original): The system of claim 1, wherein the thermal energy storage material provided within the heat exchanger is encapsulated in spheres in a baffled framework within the heat exchanger.

Claim 22 (currently amended): A thermal management system for a hybrid electric vehicle, comprising:

a first fluid loop having a first coolant mixture flowing therein;

a battery module located in the first fluid loop;

a second fluid loop having a second coolant mixture flowing therein, the second coolant mixture being distinct from the first coolant mixture;

a heat exchanger ~~having a phase change material provided therein,~~ including:

a wall defining a chamber;

a fluid flow passage inside the chamber, the fluid flow passage defining a portion of the first fluid loop;

heat exchange tubing defining a portion of the second fluid loop, the heat exchange tubing being inside the chamber but not being in fluid communication with the fluid flow passage inside the chamber;

a flexible pouch in the chamber, and phase change material in the pouch, the pouch being capable of expanding and contracting as the phase change material therein undergoes changes in density because of phase transitions; and

phase change material in the flexible pouch; and

~~the first and second fluid loops being configured to be in thermal communication with the heat exchanger, the heat exchanger being configured to flow only the first coolant mixture within the heat exchanger; and~~

a thermal interface configured to transfer heat produced by an internal combustion engine of the vehicle to the heat exchanger~~, the heat exchanger being configured to store the heat generated by the internal combustion engine and selectively provide the stored heat to control thermal characteristics of various components of the vehicle including the battery module~~.

Claim 23 (original): The system of claim 22, further comprising:

a second heat exchanger thermally coupled to the first fluid loop; and

a bypass fluid path configured to deliver the first coolant mixture to the second heat exchanger bypassing the heat exchanger in order to dissipate heat carried by the first coolant mixture and to reduce a temperature T_{Batt} of the battery module below a maximum desirable temperature T_{max}.

Claim 24 (original): The system of claim 23, wherein the heat generated by the internal combustion engine is transferred to the heat exchanger via the second fluid loop and stored therein, and the heat stored in the heat exchanger is selectively delivered to the battery module via the first fluid loop.

Claim 25 (original): The system of claim 22, wherein the heat generated by the internal combustion engine is transferred to the heat exchanger to regenerate the phase change material.

Claim 26 (original): The system of claim 22, wherein the heat generated by the internal combustion engine is transferred to the heat exchanger via a fluid path configured to be thermally coupled to the second fluid loop and a radiator core of the vehicle, and further wherein after receiving the heat generated by the internal combustion engine, at least one of a sensible heat or a latent heat of fusion of the phase change material is increased from a thermal state to a higher different thermal state.

Claim 27 (original): The system of claim 22, wherein the heat generated by the internal combustion engine is transferred to the heat exchanger via a fluid path configured to be thermally coupled to the second fluid loop and a radiator core of the vehicle, and further wherein after receiving the heat generated by the internal combustion engine, a sensible heat as well as a latent heat of fusion of the phase change material are increased from a thermal state to a higher different thermal state.

Claim 28 (original): The system of claim 22, wherein the heat generated by the internal combustion engine is selectively delivered to heat a passenger cabin of the vehicle, the passenger cabin being thermally coupled to the heat exchanger via the second fluid loop.

Claim 29 (currently amended): A thermal management system for a vehicle, comprising:

a heat exchanger means having a means for storing thermal energy;

a first coolant loop thermally coupled to an electrical energy storage means located within the first coolant loop;

a second coolant loop, the first and second coolant loops being thermally coupled to the heat exchanger means and configured to carry a thermal energy transfer medium; ~~and~~

an interface means for enabling transfer of heat generated by an internal combustion engine to the heat exchanger means in order to selectively deliver the heat to the electro-chemical storage means; and

a second heat exchanger means provided in the first coolant loop.

Claim 30 (currently amended): The system of claim 29, further comprising:

~~a second heat exchanger means provided in the first coolant loop; and~~

a bypass fluid path for delivering a first coolant mixture, provided in the first coolant loop, to the second heat exchanger means, bypassing the heat exchanger means in order to dissipate heat carried by the first coolant mixture to reduce a temperature T_{Batt} of the electrical energy storage means to within a predetermined maximum temperature T_{max}.

Claim 31 (currently amended): The system of claim 29, wherein the interface means comprises ~~comprising~~ a fluid path that is thermally coupled to the second fluid loop, and a radiator core of the vehicle is configured to be thermally coupled to the fluid path to transfer the heat generated by the internal combustion engine to the first mentioned heat exchanger means, and at least one of a sensible heat or a latent heat of fusion of the phase change material is increased from a thermal state to a higher different thermal state after receiving the heat generated by the internal combustion engine.

Claim 32 (currently amended): The system of claim 29, wherein the interface means comprising a fluid path that is thermally coupled to the second fluid loop, and a radiator core of the vehicle is configured to be thermally coupled to the fluid path to transfer the heat generated by the internal combustion engine to the first mentioned heat exchanger means, further wherein a sensible heat and a latent heat of fusion of the phase change material are increased from a thermal state to a higher different thermal state after receiving the heat generated by the internal combustion engine.

Claim 33 (currently amended): The system of claim 29, wherein the heat generated by the internal combustion engine is selectively delivered to heat a passenger cabin of the vehicle, wherein the passenger cabin is thermally coupled to the first mentioned heat exchanger means via the second coolant loop.

Claim 34 (withdrawn): A thermal management method for a vehicle, comprising:

providing a heat exchanger having a thermal energy storage material disposed therein;

providing first and second coolant loops configured to circulate distinct coolant mixtures through the respective first and second coolant loops;

thermally coupling the first coolant loop to a battery module located within the first coolant loop;

thermally coupling the second coolant loop to the heat exchanger;

providing an interface in close proximity to the second coolant loop, wherein the interface is configured to transfer heat generated by an internal combustion engine of the vehicle to the heat exchanger, via the second coolant loop, for storage within the thermal energy storage material; and

selectively performing one or more of preheating the battery module, heating a passenger cabin of the vehicle, increasing sensible heat or latent heat of fusion of the material from a first thermal state to a higher second thermal state using the heat stored within the thermal energy storage material.

Claim 35 (withdrawn): The method of claim 34, further comprising:

thermally coupling a second heat exchanger to the first coolant loop to cool the battery module; and

providing a bypass fluid path to deliver the first coolant mixture to the second heat exchanger bypassing the heat exchanger in order to cool the battery module by reducing a temperature T_{Batt} of the battery module below a maximum desirable temperature T_{max}.

Claim 36 (withdrawn): The method of claim 35, further comprising:

transferring the heat generated by the internal combustion engine to the heat exchanger via

the second fluid loop for storage in the heat exchanger; and

selectively delivering the heat stored in the heat exchanger to the battery module via the first fluid loop to increase the temperature T_{Batt} of the battery module.

Claim 37 (withdrawn): The method of claim 36, further comprising:

transferring the heat generated by the internal combustion engine to the heat exchanger; and

after receiving the heat at the heat exchanger, one or more of sensible heat or latent heat of fusion of the phase change material is increased from a first thermal state to a higher different thermal state.

Claim 38 (withdrawn): The method of claim 37, further comprising selectively delivering the heat generated by the internal combustion engine to heat a passenger cabin of the vehicle.

Claim 39 (new): A vehicle comprising:

a heat exchanger;

a first coolant loop thermally coupled to an electro-chemical storage device located within the first coolant loop and to the heat exchanger;

a second coolant loop thermally coupled to the heat exchanger, the first and second loops configured to carry distinct thermal energy transfer media;

an interface configured to facilitate transfer of heat generated by an internal combustion engine to the heat exchanger via the second coolant loop in order to selectively deliver the heat to the electro-chemical storage device;

a second heat exchanger provided in the first coolant loop, wherein, in operation, thermal energy transfer medium flowing in the first coolant loop is selectively flowed through the second heat exchanger to reduce a temperature T_{Batt} to within a predetermined temperature range;

a bypass fluid path configured to selectively deliver the thermal energy transfer medium circulating in the first coolant loop, bypassing the heat exchanger, to the electro-chemical storage device; and

first and second pumps to enable circulation of the thermal energy transfer media provided in the respective first and second coolant loops.

Claim 40 (new): The vehicle of claim 39, further comprising a plurality of three-way valves configured to selectively permit the thermal energy transfer medium flowing in the first coolant loop to flow through the heat exchanger or the bypass fluid path.

Claim 41 (new): The vehicle of claim 39, wherein the thermal energy transfer medium flowing in the first coolant loop is flowed via the bypass fluid path if a temperature T_{Batt} of the electro-chemical storage device is above a predetermined maximum threshold temperature T_{max}.

Claim 42 (new): The vehicle of claim 39, wherein the thermal energy transfer medium flowing in the first coolant loop is enabled to flow through the heat exchanger if a temperature T_{Batt} of the electro-chemical storage device is below a predetermined minimum threshold temperature T_{min}.

Claim 43 (new): The vehicle of claim 39, wherein the second heat exchanger comprises air-to-glycol mixture heat exchanger.

Claim 44 (new): A vehicle comprising:

an internal combustion engine;

a heat exchanger;

a first coolant loop thermally coupled to a battery located within the first coolant loop;

a second coolant loop, the first and second coolant loops being thermally coupled to the heat exchanger and configured to carry a thermal energy transfer medium;

an interface for enabling transfer of heat generated by the internal combustion engine to the heat exchanger in order to selectively deliver the heat from the engine to the battery; and

a second heat exchanger provided in the first coolant loop.

Claim 45 (new): The vehicle of claim 44, further comprising a bypass fluid path for delivering a first coolant mixture, provided in the first coolant loop, to the second heat exchanger, bypassing the first mentioned heat exchanger in order to dissipate heat carried by the first coolant mixture to reduce a temperature T_{Batt} of the battery to within a predetermined maximum temperature T_{max}.

Claim 46 (new): The vehicle of claim 44, and further comprising a radiator core, wherein the interface comprises a fluid path that is thermally coupled to the second fluid loop, and wherein the radiator core is configured to be thermally coupled to the fluid path to transfer the heat generated

by the internal combustion engine to the first mentioned heat exchanger.

Claim 47 (new): The vehicle of claim 44, and further comprising a radiator core, wherein the interface comprises a fluid path that is thermally coupled to the second fluid loop, and the radiator core is configured to be thermally coupled to the fluid path to transfer the heat generated by the internal combustion engine to the first mentioned heat exchanger.

Claim 48 (new): The vehicle of claim 44, wherein the heat generated by the internal combustion engine is selectively delivered to heat a passenger cabin of the vehicle, and wherein the passenger cabin is thermally coupled to the first mentioned heat exchanger via the second coolant loop.